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EDITORIAL NOTES

SCIENCE IN WAR

IN the "JOURNAL" a fortnight ago, under the title of "Science and Progress," we referred to Messel Lecture delivered to the Society of Chemical Industry by Lord Samuel, which, in philosophic vein, discussed the subject of science and civilization. The question asked was whether scientists are pioneers in an upward march of mankind towards greater well-being or whether in fact their work is misguided and may lead to ultimate destruction. As chemistry and physics and engineering advance, the perversion of their discoveries to the use of war becomes more and more deadly, but that is not the fault of the scientist; most of the inventions employed in war were originated for purposes of peace. At the same meeting Professor Philip, in his Address as President of the Society, expressed the opinion that it is a wholly superficial view which holds science especially responsible for the prostitution of its resources to destructive ends. In any case the successful prosecution of modern warfare depends on the fullest application of science and it may be queried whether the fullest use is as yet being made by us of scientific thought and scientific method.

We have been reading a little book entitled "Science in War" (Penguin Special, price 6d.), which we heartily commend and which gives a strong negative to this question. It is a timely book and one of extraordinary interest; it is to be hoped that it stimulates not only thought, but action. What the book calls for "not as an ideal but as an urgent practical need in a desperate situation is the effective utilization of scientific thought, scientific advice, and scientific personnel." That it is essential to break down the traditional resistance of administrators to a general scientific approach to the problems of national existence. In a publisher's note it is explained that "Science in War" crystallizes the discussion of a group of distinguished scientists who met round a dinner-table a few weeks ago. It is the first Penguin Book to be issued anonymously, but that can be understood in the circumstances, and it is obvious that the statements so clearly set out are the outcome of intimate knowledge of the problems discussed.

The scientific societies, it is argued, which might have integrated the scientific effort of the country, have almost gone into hibernation, and preserve a precarious existence carrying on their pre-war functions and assisting, somewhat ineffectively, in the operation of the National Register. "There is a shortage in applied intelligence in this country perhaps greater than the shortage of anything else. This shortage will not be met until we make use of the large quantity of available, but at present unemployed, scientific intelligence we have at the moment." This is quoted from the introduction to the book, which then goes on to deal in turn with some of the accomplishments of science; science in the conduct of war; the wounded; food; and the background of industry. Among other contentions it is urged that the Government should set aside an adequate subsidy for the investigation of the use of liquid methane, and for the purpose should organize a group of chemists and engineers with the best possible facilities. It is suggested that, while remarkable scientific results in the improvement of processes, especially in the coal and refractories industries, have been achieved through the encouragement of the Department of Scientific and Industrial Research, the results arouse little enthusiasm because their benefits are evenly distributed through the industries. A very large number of problems the solution of which demands the scientific approach are touched upon in "Science in War," including lighting, heating, and cooking, the greater use of fertilizers, the development of grass drying—subjects of special concern to the Gas Industry, the progress of which in recent years has been so largely influenced by a greater appreciation of the value of research and the application of scientific method.

We may well conclude this note on "Science in War" by quoting from an article in the *Sunday Times* of Aug. 11 by Lord Horder, who wrote of the importance of efficient lighting and ventilation and of scientifically planned diet: "We must watch our national vices and repent of them in time. Let us face the truth: we British are not scientifically-minded; we pay lip-service to research but we are not really interested; method is not one of our national characteristics. Perhaps Nature has spoilt us; anyway in the absence of a strong incentive we are casual and lazy-minded and we have left for a long time almost entirely unimplemented many of the discoveries that science hands out to us." The need for science and its application was never more evident; the need for organizing for its most effective use never more urgent.

CEMENT SUPPLIES

THE Gas Industry has been affected by interruptions in the normal flow of many raw materials since the war began, and is at present experiencing what may prove to be no more than a temporary difficulty in getting cement, of which it consumes considerable quantities not only for essential new construction but for the repair and maintenance of existing plant. So far as we have been able to investigate the position it appears that there is a good deal of cement in the country, but most of it is at present needed for work of urgent national importance and the appropriate Government Departments therefore have the first priority in regard to its use. It has been found necessary to set up a "Cement Control" which will function very much as do the established Controls on such raw materials as iron, steel and timber. A specific allocation of cement has, it is understood, been made for distribution to gas undertakers, and this should facilitate providing undertakers with supplies for essential purposes. Gas undertakings needing cement should, therefore, make application for a certificate of allocation to the Director of Gas Administration, 26, Chapter Street, London, S.W. 1, stating the tonnage required, the period (a period corresponding with a quarter of the year), during which the cement is required to be delivered to the undertaking, and full particulars of the purposes for which the cement is to be used. In cases in which any particular difficulty is encountered in obtaining the cement, and that material is required for urgent essential purposes, application should also be made to the Director of Gas Administration for priority to be given to the supplies, stating the particular reason for priority.

ALUMINIUM CONTROL

AN Order—Control of Aluminium (No. 5) Order, 1940, No. 1449—which comes into force to-day transfers the responsibility for the control of aluminium from the Ministry of Supply to the Minister of Aircraft Production. The new Order repeats the main provisions of the existing Order, subject to certain modifications. In particular a licence is required for the treatment, use, or consumption of aluminium scrap and aluminium alloy scrap save for the purpose of converting it into ingots. The grinding of foil scrap to produce powder and the "destructive" use of scrap for such purposes as steel de-oxidation or the manufacture of aluminium bronze are now subject to licence. The cleaning, crushing, bulking, and sorting of scrap in the course of collection and merchanting continue to be exempt from licence.

All acquisitions of aluminium and aluminium alloy and all disposals of aluminium and of aluminium alloy must be effected under licence. Licences will not be granted to anybody to acquire or dispose of aluminium or aluminium alloy simply for the purpose of dealing in it. Further information may be obtained from the Aluminium Control, Southam Road, Banbury. In addition, the Ministry of Aircraft Production will be responsible for bauxite, cryolite, and silicon metal.

CRUDE TAR PRICES

THE impossibility of giving a crude tar price, in the absence of any market price for pitch (which comprises 50-60% of a ton of crude tar), has, we understand, raised difficulties in the case of a number of contracts which are based upon the price normally given in the "JOURNAL" from week to week. Our Market Correspondent is not prepared to give a "nominal" price for pitch, upon which a tar price could be based; there was, we believe, trouble in the Courts over such a price at the end of the last War. Our Correspondent suggests that parties might perhaps agree among themselves upon a price to be paid on account, on the understanding that when there is again a market for pitch we should try to fix upon a composite price for pitch to cover the period which has intervened, and also give what we think would be a fair price for tar, based upon that figure, for each month of the period during which no prices for crude tar have been inserted. We shall be grateful if interested parties will write to us giving their views upon such an arrangement, so that if there is any concensus of opinion we can act accordingly.

Timber Control

Describing the procedure for obtaining supplies of timber for use in the Gas Industry last week we said that "timber required for essential repairs and maintenance can be obtained without licence." We should have said that direct application for licence for such timber could be made to the appropriate Timber Control Area Officer without the necessity for first obtaining from the Director of Gas Administration a certificate to purchase. A certain quantity of timber has been allocated for these purposes, as distinct from timber for new construction.

Forthcoming Engagements

Aug.

26.—L.C.C.A.—Finance Committee, 11 a.m.; Executive Committee, 11.30 a.m.; Central Committee, 2.30 p.m. [Date changed from Aug. 19.]

Sept.

4.—I.G.E.—Corbet Woodall Scholarship Committee, 2 p.m.

6.—North British Association.—Date provisionally fixed for Annual Meeting at Edinburgh. Papers by Mr. A. B. Munro (Edinburgh) and Mr. J. M. Dow (Kirkcaldy).

10.—I.G.E.—Finance Committee, 2 p.m.; Membership Committee, 2.30 p.m.

17.—I.G.E.—Gas Education Executive Committee, 11 a.m.; Gas Education Committee, 2 p.m.

19.—Gas Research Board.—Refractory Materials Joint Committee, 2.30 p.m.

26.—Gas Research Board.—Joint Committee on Complete Gasification Under Pressure, 2.30 p.m.

27.—Gas Research Board.—Joint Research Committee, 2 p.m.

27.—I.G.E.—Liquor Effluents and Ammonia Committee, 12.15 p.m.

Personal

Mr. A. G. SAUNDERS, of the technical staff of the Runcorn and District Gas Company, has been appointed assistant to the Engineer and Manager of the Ormskirk and District Gas Company. Mr. Saunders joined the Runcorn Company in 1919, and has studied gas engineering, fuel chemistry, and allied subjects at Liverpool. He takes up his new appointment later this month.

* * *

Mr. J. W. FELL, Superintendent of the Basford Gas-Works, Nottingham, who has retired after 22 years' service, has been presented with a wireless set by his colleagues in the Gas Department. The presentation was made by Mr. Geo. Dixon, the Engineer and Manager of the Department, at a gathering in the Demonstration Theatre.

Obituary

The death has occurred of Alderman Sir JAMES CROOKS, J.P., who for the past 35 years had been Chairman of the St. Helens Corporation Gas Committee. Under his capabale and singularly active chairmanship and with such Engineers as Mr. Samuel Glover, Mr. F. E. Ward, and now Mr. R. L. Greaves, the St. Helens Gas Department has been kept abreast of the times. During Sir James' period of office the Gas Department has contributed more than £120,000 to the relief of the rates and at the same time maintained the reputation for being one of the cheapest municipal gas suppliers in the country. Sir James was made a Borough Magistrate in 1902, and had spent a life, full of records in municipal service, actively associated with the welfare of his native town and its development.

* * *

The death occurred suddenly on Aug. 3 of Mr. JOHN EDGAR MERRY, of Higham. He was a Director of the South Normanton and Blackwell Gas Company.

Standard Specification for Ventilator Light-traps

A British Standard Specification for Light-locks at Entrances to Buildings was issued some time ago as BS/ARP 15.

Since that time many factories and office buildings have had to be in use during black-out hours in warm weather, and the ventilation of the buildings has given rise to many problems. It has been necessary to obstruct the windows and other openings in such a way as to provide a light-trap without interfering with ventilation, and with a view to giving guidance in this matter a new specification has just been issued by the British Standards Institution. This specification, which bears the reference BS/ARP 31, and the title "Ventilation for Buildings in Conditions of Black-out," has been prepared under the ægis of the Joint Lighting Committee of the Ministry of Home Security and the Illuminating Engineering Society. It describes the principles of design, the effect of light-traps on ventilation, and suitable materials for the construction of ventilator light-traps. Numerous illustrations of typical light-traps suitable for various circumstances are then given.

Although primarily designed for premises such as factories, ventilator light-traps are also applicable to domestic premises, and the construction of suitable light-traps should not be beyond the scope of householders themselves, using materials readily to hand and working to one of the examples clearly illustrated in the specification.

Copies of this specification may be obtained from the British Standards Institution, Publication Department, 28, Victoria Street, London, S.W.1; price 8d., post free.

Further British Standards

Copies of the following recently published British Standards Specifications may be obtained, at the stated prices, from the Secretary of The Institution of Gas Engineers, 1, Grosvenor Place, S.W.1.

BS/ARP 18. Fluorescent and Phosphorescent Paint (excluding Radio-active Materials) for A.R.P. Purposes. 1st Revision. Price 1s.

BS/ARP 13. Ventilation for Buildings in Conditions of Black-Out. Price 6d.

Supplement to BS/ARP 33. Drawings of a Stirrup Pump Designed to Comply with BS/ARP 33. Price 6d.

916-1940. Dimensions of Black Bolts and Nuts. (Small Hexagon and Square.) B. S. Whit and B. S. Fine. Price 2s.

NEWS OF THE WEEK

Two Fuelling Stations are to be installed by the Southport Gas Committee in Eastbank Street and Crowlands for the supply of gas for use on motor transport.

To Meet Anticipated Expenditure in connexion with the hire purchase of appliances during the period ending Sept. 30 next, the Burnley Gas Commitee have obtained sanction to borrow £3,750. The Southport Gas Department has also obtained consent to borrow £1,500 for the provision of gas appliances.

An Offer to supply half a million cu.ft. of coke oven gas daily to the Glasgow Gas Department has been made by James Nimmo & Co. The offer, which provided for increasing the supply to one and a half millions daily, was considered by the Gas Committee on Aug. 5, and a report on the matter is to be made by the Gas Manager. The price proposed is similar to that at which the Department recently entered into an agreement with Messrs. Dixon—who have undertaken to supply 5 million cu.ft. a day—and is approximately 7½d. per 1,000 cu.ft. of purified gas.

Eight Hundred Gas Lamps equipped with wartime fittings will illuminate the streets of Hinckley, Earl Shilton, Barwell and Burbage, as from the second week in September. Hinckley was one of the first towns in the country to introduce gas "starlights" last winter, when several main streets were lighted. The experiment proved so popular that the Council decided upon a scheme for the whole of the urban area. Council workmen have been refitting the lamps for many weeks, and Mr. A. B. Britton (Engineer, Manager, and Secretary of the Gas Department) has announced that the work is nearing completion.

With a Prospective Surplus of £6,200—more than double that of last year—and after considering the current estimates for the year, the Gas Committee of the Glasgow Corporation have come to a decision to make no alteration in the price of gas. The Engineer and Manager estimates that the revenue for the year will amount to £1,851,200, and the expenditure to £1,845,000. The estimated expenditure is £134,478 more than was required in the past year, factors contributing to the increased costs of production including the higher price of coal and the increased rates granted to gas workers in June. The quantity of coke available for marketing this year is likely to be reduced by as much as 80,000 tons in consequence of the operation of carburetted water gas at the Provan Works and the introduction of coke oven gas.

Ellesmere Port Not to Sell Undertaking

The Ellesmere Port Urban Council have approved a recommendation of the Law and Parliamentary Committee that the agreement between the Runcorn and District Gas Company and the Council to sell the gas undertaking should be treated as null and void.

It was explained that, owing to the war, there was no hope of the Board of Trade Order being obtained by Sept. 30. The United Kingdom Gas Corporation and the Council had had dual control of the gas undertaking, but the Council felt it was not in the best interests of the undertaking for that dual control to continue, and it had been mutually agreed that the Order should be made null and void.

The loss of £5,627 on the undertaking in the year to March 31 last was £550 less than the previous year, although wages had increased by £400. This year £1,900 fell out of charge, to be followed by £2,540 in 1941. Expenditure on the works would have to be made in the very near future, but the saving of £4,440 to the sinking fund, the increased consumption now prevailing, and the better and more economical working of the plant, would leave the Undertaking in a much better position. For the three months to June 30 last, receipts were up by nearly £3,000.

Machinery and Plant

Limitation of Home Supplies

The *Board of Trade Journal* dated Aug. 8 draws the attention of manufacturers of machinery and plant of the classes set out in the Schedule to the Machinery and Plant (Control) (No. 2) Order, 1940, and of persons who desire to acquire such machinery and plant, to Article 4 of the Order, which provides that the machinery and plant described in the Schedule shall be deemed to include any steam generator (including feed-water supply), prime mover, electric generator (including control equipment), and electric motor exceeding 15 horse-power (including control equipment) designed or appropriated for use in conjunction with any such machinery or plant.

Applications in respect of such machinery and plant should be addressed to the Industrial Supplies Department (Machinery Licences Division), HO, Board of Trade, 25, Southampton Buildings, London, W.C.2.

Tube List Changes

Important changes in the qualities of wrought tubes are announced by manufacturers. Instead of the familiar mild steel gas, water and steam quality tubes made for so many years there will be a "light weight" and a "heavy weight" only, the former being one gauge lighter than present gas quality and the latter equivalent to present water quality. The alterations have been decided upon by Gas List steel tube and wrought fitting manufacturers, and will take effect when existing stocks of gas and steam tubes are exhausted; but it is understood—states the *Ironmonger*, from which we take the accompanying table—that puddled wrought-iron light weight tubes will not be supplied.

Tubes as described below with standard screwed and socketed joints are suitable under normal conditions for the following working pressures in lb. per sq.in.

Nom. Bore	Approx. Out. Dia.	"Light Weight" Tubes Tested to 500 lb. per sq. in.			"Heavy Weight" Tubes Tested to 700 lb. per sq. in.		
		Thickness (Imperial Wire Gauge)	Service Gas (a) Water (b) Not recommended for Air or Steam		Thickness (Imperial Wire Gauge)	Service Water, Air and Steam (c)	(d)
⅛	13/32	15	Ordinary Pressures	150	13	300	150
¼	17/32	15		150	13	300	150
⅜	21/32	14		150	12	300	150
½	27/32	13		150	11	300	150
¾	1 5/32	12		150	10	300	150
1	1 11/32	11		150	9	300	150
1¼	1 11/16	10		125	8	250	125
1½	1 29/32	9		125	7	250	125
2	2⅜	9		125	7	250	125
2½	3	8		125	6	250	100
3	3½	8		125	6	250	100
3½	4	8		100	6	200	80
4	4½	8		100	6	200	80
5	5½	8		100	6	150	60
6	6½	8		100	6	150	60

Gas Water Heating Displays

The above photographs illustrate current single-point and multi-point water heater window displays—two of a number which are at present in use in the showroom windows of gas undertakings, builders' merchants, &c., up and down the country. These were provided by the B.C.G.A., and are of attractive appearance and design. Messrs. Ewart & Son, Ltd., will be glad to place one or all of them at the disposal of gas undertakings which have not yet taken advantage of them

Results at Lancaster

The quantity of gas sold, including that for public lamps, by the City of Lancaster Gas Department during the year to March 31 was 434,821,000 cu.ft., a decrease of 22,388,000 cu.ft. when compared with the sales of the preceding year, or 4.9%. The suspension of street lighting, however, accounted for a decreased consumption of 46,918,000 cu.ft., so that, apart from this item, the gas sold to consumers amounted to 419,487,000 cu.ft., as against 394,957,000 cu.ft. for the previous year—an increase of 25,153,000 cu.ft., or 6.36%. There having been an increase in the price of gas as from Jan. 1, the net income from sales averaged 2s. 7.19d. per 1,000 cu.ft. (including public lamps). This compares with an average of 2s. 5.52d. per 1,000 cu.ft. of gas sold during the previous year. The number of consumers increased during the year by 96, bringing the total to 12,782, of whom 7,524 are on the prepayment system. The gross profit carried to Net Revenue Account is £6,738, and the balance of net profit carried to Appropriation Account, £2,542.

ANOMALIES IN THE PROPERTIES AND BEHAVIOUR OF SILICA BRICKS

By

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From a Paper given at a recent Meeting of the Refractory Materials Section of the British Ceramic Society at Stoke-on-Trent

DURING the routine testing of silica bricks purchased from various manufacturers, it was found that certain bricks from a particular source were characterized by a much lower after-expansion than would have been expected from their true specific gravities and gave a rather dead ring when struck. The true specific gravity, which ranged between 2.35 and 2.36, did not fall, but tended to increase when the bricks were reheated to temperatures of 1,450° C. or higher. The bricks in question tended to be oversize, and their porosity was higher than normal.

An explanation of the behaviour of the bricks was sought by means of an investigation which covered the following points:

(1) The manufacturing conditions, including the kiln firing.
(2) The nature of the rocks employed for the manufacture of the bricks, including their composition and crystallographic structure.
(3) The grading of the brick mixture.
(4) The chemical composition of the bricks.
(5) The effect of heat treatment on the physical properties and crystallographic structure of the bricks.

It is concluded that the weak structure was due to an excessive content of fines in the brick mixture and to a too rapid rate of temperature rise in the final stages of the kilning. The first factor leads to a dilution of the fluxes and a consequent loss of elasticity in the matrix, while the second factor gives rise to the formation of strains and to the development of cracks due to the high speed at which conversion of the quartz occurs under such conditions. The high content of fines in the brick mixture is believed to have been due to the use of a variety of rocks differing in hardness and to the particular order in which the individual rocks were charged to the pans.

Examination of thin sections under the microscope showed that the increase in true specific gravity caused by heat treatment was accompanied by a conversion of tridymite into cristobalite. The results of tests on bricks of a number of different makes suggest that this increase in specific gravity is generally associated with bricks containing less than 95% of silica as a result of an abnormally high content of alumina or lime or both. The increase in specific gravity may occur in the kiln itself after a minimum value has been attained, if the firing conditions are too drastic. In the case of such bricks, it would appear that the true specific gravity alone does not enable a decision to be made as to whether the heat treatment in the kiln has been inadequate or excessive.

As is well known, all forms of silica rock suffer a considerable permanent expansion and a decrease in true specific gravity when exposed to a sufficiently high temperature. In the manufacture of lime-bonded silica bricks it is of paramount importance for the kiln firing to be carried out at a sufficiently high temperature and for a sufficiently long period to ensure the conversion of most, if not all, of the silica into the low specific gravity forms, cristobalite and tridymite; otherwise expansion of the residual quartz may give rise to troubles when the bricks are subsequently used.[1]

Among the most important of the tests employed for the assessment of the quality of silica material are those involving the determination of the after-expansion and true specific gravity of the bricks. The present Paper deals with some anomalies encountered in the course of these tests and with the effect which composition and grain size may have on the properties of certain abnormal silica bricks.

Tests Specified by the Institution of Gas Engineers

For some years prior to 1934 the specifications of the Institution of Gas Engineers required that silica bricks, when heated in the form of test-pieces for two hours at 1,410° C. should not show an after-expansion exceeding 0.5% with a tolerance of ±0.1% for experimental error. It was, however, felt in certain quarters[2] that, in view of the slow rate of conversion of some types of silica rock at this temperature, the test was not nearly drastic enough to provide an effective guarantee of the volume stability of silica bricks, since many bricks which passed the test had a rather high true specific gravity, indicative of the presence of unconverted quartz. In 1934, therefore, the temperature specified for the test was raised to 1,450° C., though no alteration was made in the duration of the heating or in the maximum permissible after-expansion. It has, indeed, been suggested that the new temperature is still too low, though it has been pointed out[3] that tests at a higher temperature are frequently unsatisfactory owing to the development of cracks in the test-pieces.

Though the 1934 specifications contain a note on the "True Specific Gravity and the Degree of Conversion of Quartz in Silica Material," a maximum limit for the true specific gravity of silica bricks is not laid down. It is, however, known that certain large users of silica bricks insist on a true specific gravity not higher than 2.35.

Preliminary Routine Tests

Early in 1939, in the course of routine tests in the Woodall-Duckham Laboratories, abnormal results were obtained in the case of several samples of silica bricks of a certain make. Check samples from the same consignments gave similar results. The material in question was characterized by a true specific gravity ranging between 2.35 and 2.36, a porosity about 3-4% higher than the normal figure for the make of bricks concerned, a very low after-expansion at 1,450° C., and a noticeable structural weakness coupled with a rather dead "ring." Table I gives details as to the properties of the bricks in question.

TABLE I.—AFTER-EXPANSION, TRUE SPECIFIC GRAVITY, AND POROSITY OF ROUTINE SAMPLES OF ABNORMAL SILICA BRICKS.

Sample Number.	After-Expansion at 1,450°C. %	Specific Gravity.		Porosity, %	Remarks.
		True.	Apparent.		
14,849	0.06	2.36	1.62	31.5	
14,946	0.07	2.35	1.65	30.0	Checks on sample 14,849.
14,947	0.03	2.36	1.63	31.1	
14,863	0.12	2.36	1.63	30.8	
14,970	0.16	2.36	1.62	31.6	Checks on sample 14,863.
14,971	0.12	2.36	1.60	32.4	
14,929	0.10	2.36	1.65	30.3	
14,997	0.10	2.36	1.65	30.2	Checks on sample 14,929.
14,998	Nil	2.35	1.67	28.9	
14,941	0.08	2.35	1.65	29.8	
14,995	0.11	2.35	1.63	30.7	Checks on sample 14,941.
14,996	0.08	2.36	1.63	30.6	
14,949	0.03	2.35	1.64	30.3	

Investigation at the Works

The properties of these bricks were sufficiently unusual to warrant an enquiry as to whether some changes had been made in the source or type of the rocks employed, in the grain size of the batch, or in the firing schedule. It was ascertained that, in the kiln in which some, at least, of the bricks had been fired, the desired rate of heating was not maintained, a rather rapid rise of temperature having apparently occurred towards the completion of the firing due to the effect of a high wind on the draught conditions during one night. The average true specific gravity of 15 samples drawn from the several parts of the kiln by the makers was 2.336, with a maximum of 2.355. It was further stated that the bricks which were the subject of discussion had, for convenience, to be set at the top of the kiln in view either of their small size or particular shape. With the type of kiln in use at this works, bricks set in this position would suffer the brunt of any sudden increase in temperature which might occur during the burning operation.

In the preparation of the brick batch, three or four rocks from different localities are normally mixed in definite proportions. In connexion, however, with a contemplated substitution of one rock by another, bricks from each of the four individual rocks and from the normal mixture had been made and had been fired simultaneously in one part of the same kiln, the commercial bricks from which had an average true specific gravity of 2.34.

Table II gives the results obtained by the makers on these experimental bricks and on the brick made from the normal mixture. The results are confirmed by those obtained in the Woodall-Duckham Laboratories.

TABLE II.—TESTS BY THE MAKERS ON BRICKS MADE FROM INDIVIDUAL ROCKS AND FROM THE NORMAL MIXTURE.

Sample No.	Rock Used.	Specific Gravity.		Porosity, %
		True.	Apparent.	
15,060	15,418	2.32	1.88	19.2
15,061	Normal mixture.	2.34	1.76	24.8
15,062	15,420–1*	2.35	1.69	28.1
15,063	15,419	2.36	1.78	24.6
15,064	15,417	2.34	1.86	20.0

* Rocks 15,420 and 15,421 represent two different levels of the same type of rock and are apparently used indiscriminately.

The rate of conversion of the quartz varies, of course, with the nature of the rock. The relatively low true specific gravity of brick 15,060 would appear to be due to the fact that the rock employed for its manufacture contained a proportion of amorphous

silica, this being noticeable in the microsection of the rock. As is well known, amorphous silica ultimately easily attained a specific gravity as low as 2.25.

The character of the individual rocks employed in the manufacture of bricks 15,060, 15,062, 15,063, and 15,064 was studied by the examination of thin sections and test-pieces of the rocks were fired for two hours at 1,500° C. The after-expansion was measured and porosity and specific gravity determinations were made on the raw and fired test-pieces. The results are given in Tables III and IV.

Rock 15,418, which contained a considerable proportion of amorphous silica and showed a wide diversity in the size of its grains, was the hardest and least porous of all the rocks in both the raw and fired states.

On the other hand, rock 15,417, though very hard in the raw state, was very friable and porous in the fired condition. These features are in harmony with the very uniform grain size of the rock which, incidentally, suffered a larger reduction in true specific gravity as a result of the heating than did any other rock. In view hence, this factor will influence the rate of conversion and also the relative proportions of cristobalite and tridymite. For this reason, also, rock 15,417 would have an unfavourable effect on the structure of a brick if the latter were fired rapidly at a temperature exceeding, say, 1,450° C.

TABLE III.—Properties of the Individual Rocks in the Raw State and after Heat Treatment at 1,500° C. for 2 Hours.

Sample Number.	Raw Rocks.			Rocks Heated at 1,500° C. for 2 Hours.			
	Specific Gravity.		Percentage Porosity.	Percentage After-Expansion.	Specific Gravity.		Percentage Porosity.
	True.	Apparent.			True.	Apparent.	
15,417	2.66	2.57	3.2	12.4	2.36	1.77	24.8
15,418	2.66	2.66	0.3	7.5	2.38	2.13	10.3
15,419	2.66	2.59	2.8	8.9	2.41	1.97	18.1
15,420	2.66	2.54	4.3	7.2	2.39	2.04	14.8
15,421	2.65	2.47	6.9	7.5	2.42	2.03	15.7

TABLE IV.—Results of Microscopic Examination of the Rocks.

Sample Number	15,417	15,418	15,419	15,420	15,421
Section Number	27	38	29	30	31
Number of corresponding brick	15,064	15,060	15,063	15,062	
Average diameter of grains (mm.)	0.2–0.3	Largest 0.5 ; many 0.06 and smaller.	0.1–0.15	0.2	0.2
Average area of grains (sq. mm.)	0.04 (largest 0.088).	? (largest 0.125).	0.018 (largest 0.03).	0.019 (largest 0.05).	0.03 (largest 0.05).
Texture (grain size)	Very uniform in grain.	Variable, but not much intermediate sized material.	Fairly uniform.	Generally uniform.	Similar to 15,420 but graded slightly better.
Accessory minerals	Mica in moderate amount.	Micaceous matter around larger grains.	Fair amount of micaceous matter. Matrix stained with ferruginous matter.	Small amount of plagioclase ; rutile, zircon, mica.	Similar to 15,420, but more rutile inclusions.
Remarks	—	Bands of chalcedonic material among fine portion.	Matrix amorphous.	A little chalcedonic material.	

of the behaviour of this rock when heated to a high temperature, particular care would appear to be necessary in the kiln-firing of bricks made entirely or mainly from it, for the bricks would be likely to develop structural weakness if fired rapidly to a temperature in the neigbourhood of 1,500° C. It is difficult to reconcile the low porosity of brick 15,064 with the fact that rock 15,417, from which it was made, has so high a porosity in the fired condition. The rock may possibly be of variable quality or of such a structure that it readily reduces to a fine condition despite its hardness. Alternatively, it may develop intergranular porosity when fired in the pure form, but may exhibit this feature to a much smaller degree when made into a lime-bonded brick.

On the porosity of the ultimate grains of rock depends their susceptibility to attack by the lime and impurities in the matrix ;

Influence of Grading

No details are available as to the grading of the batches from which the experimental bricks were made. The effect of the hardness of the rock on the grain size of the batch is, however, very marked and is distinctly observable in the fired bricks. Rock 15,418 is the hardest one. It gives much material of coarse and intermediate sizes and is not readily reduced to flour. Rocks 15,419, 15,420, and 15,421, though a little variable, readily produce a high proportion of fines and give rise to bricks with a higher porosity.

In the decision as to the optimum proportion of fines or flour required for the production of bricks of good quality, a balance must be struck between an excessive amount, resulting in loss of high temperature rigidity, and a deficiency, which would produce

TABLE V.—Results of Microscopic Examination of Bricks.

Sample Number.	Section Number.	Firing Temperature, °C.	Distribution of Crystal Forms.		
			Quartz in Coarse Grains.	Cristobalite in Coarse Grains.	Tridymite Development in Matrix.
14,946	1	—	Few remnants.	Mainly cristobalite.	Moderate.
14,946	8	1,500	Traces only.		
14,996	17	1,600	None.	Entirely. Coarse grains much shattered.	Good.
14,971	2	—	None.	Grains mainly cristobalite. Slightly more crack development in No. 10 than in No. 2.	Moderate.
14,971	10	1,500	None.		
15,060	3	—	Main constituent. Little present.	Coarse grains much broken up.	Fair.
15,060	11	1,500	Some present. Less than in No. 3.	More than in No. 3.	
15,060	23	1,600	None.	Entirely.	
15,062	4	—	Much.	More in No. 12 than in No. 4.	Moderate amount of large crystals in Nos. 4 and 12. Slightly less in No. 24.
15,062	12	1,500	Less than in No. 4.		
15,062	24	1,600	None.	Entirely.	
15,063	5	—	Much present.	Thick borders around quartz grains.	Moderate.
15,063	13	1,500	Slightly less than in No. 5.		Slightly more than in No. 5.
15,063	25	1,600	Mere remnants.	Mainly cristobalite.	Less than in Nos. 5 and 13.
15,064	6	—	Fair amount.	—	Moderate.
15,064	14	1,500	Less than in No. 6.	—	Slightly more than in No. 6.
15,064	26	1,600	None.	Much. Cracks in form of " fish-scale " pattern.	Slightly less than in Nos. 6 and 14.
15,065	7	—	None.	Grains mainly cristobalite. More shattering in No. 15 than in No. 7 and still more in No. 18.	Many coarse crystals.
15,065	15	1,500	None.		Slightly more than in No. 7.
15,065	18	1,600	None.		
15,066	8	—	None.	Much. Grains show shattering and " fish-scale " cracking, No. 16 being worse than No. 8.	Fair to moderate amount.
15,066	16	1,500	None.		
15,066	19	1,600	None.		
15,255	20	—	Much.	Thick border around quartz grains.	Moderate.
15,255	21	1,450			Slightly more than in No. 20.
15,255	22	1,600	None.	Much " fish- scale " cracking.	Less than in Nos. 20 and 21.

Samples 15,060, 15,062, 15,063, and 15,064 are bricks made from individual rocks.
Samples 15,065 and 15,066 are bricks with a good structure (low alumina content) and a weak structure (high alumina content) respectively.
Samples 14,946, 14,971, and 14,996 are routine samples of abnormal bricks.
Sample 15,255 represents a brick of a different make.

mechanical weakness. The optimum proportion depends, among other factors, on the amount of lime employed and on the percentage of material other than silica, present in the rick. Le Chatelier has suggested that 25% is a suitable proportion when the lime content is 2%.[4], [5].

It would seem that the higher porosity of the bricks made from rocks 15,419, 15,420, and 15,421 in comparison with that of the bricks made from the other two rocks is associated with a greater proportion of fines. Sieve tests on brick batches indicate that a greater percentage of fines is present in the mixture employed for the manufacture of special shapes than in that used for squares. A sample of an unfired 3-in. square brick contained only 18% of material finer than 200 mesh, whereas 45% was present in the batch used for the manufacture of a special shape represented in the finished form by sample 15,179, which in texture was similar to the abnormal bricks included in Table I. All of these were special shapes.

The use of an increased proportion of fines in the manufacture of special shapes appears to be a general practice, the aim being to improve the moulding qualities of the batch and to ensure sharp corners and arrises and a good finish or skin.

The effect on the matrix of an increased proportion of fines may now be considered. In the first place, the matrix would be rendered weaker and less elastic as a result of the greater dilution of the added lime. Though the rate of conversion of the quartz into tridymite and cristobalite would, in virtue of this dilution, be reduced, the greater fineness of the quartz would have a compensating effect by promoting a more rapid rate of conversion.[6]

As a result of the above-mentioned diminution in the elasticity of the matrix, any sudden increase in temperature in the higher regions of the firing schedule might lead to the development of cracks caused by the sudden strains imposed by a rapid rate of quartz conversion.[7], [8]. Thus, a brick with a characteristic punky structure would be produced. Such a brick is almost invariably oversize.

An exaggerated case of this nature has been encountered in another connexion in a batch of bricks made from a mixture containing about 70% of material finer than 200 mesh. The bricks had a remarkably dead ring though their analysis was normal.

Microscopic Examination of Bricks

It would seem from an examination of micro-sections of the original bricks and of portions fired at 1,450° or 1,500° C. that refiring at these temperatures causes, in some cases, a slight increase in the amount of tridymite in the matrix (sections 13, 14, 15, and 21). In other cases (sections 11, 12, and 16) the proportion remains the same as it was in the brick as received.

Refiring at 1,600° C., however, tends to decrease the percentage of tridymite in the matrix of several of the bricks and to increase the content of cristobalite. This may account to some extent for the observed increase in specific gravity which occurs as a result of the firing at 1,600° C. notwithstanding the simultaneous disappearance of residual quartz.

A "fish-scale" type of shattering of the cristobalite grains occurred to a marked extent in some cases, notably in sections 8, 16, 17, 18, and 19. As this feature seems to develop and to become more prevalent in the case of some bricks after they have been fired at 1,600° C., it is suggested that a temperature—probably of short duration—tending towards this figure had been attained during the original kiln-firing of certain of the bricks and had produced the same phenomenon.

It may be pointed out that although the proportion of quartz revealed by microscopic examination was apparently quite marked in certain sections (Nos. 3, 4, 5, and 6), the reduction in the true specific gravity when these bricks were refired at 1,450° C. or 1,500° C. was slight, this being probably due to conversion of tridymite into cristobalite simultaneously with the conversion of the residual quartz.

It will further be seen that the coarser grains consist either of quartz or of cristobalite; the occurrence of tridymite is confined to the matrix in all cases. In some instances in which quartz grains remain, these grains are bordered with cristobalite and conversion has thus been taking place by attack of the matrix, whereas in those cases in which the conversion of the residual quartz was solely a temperature effect, shattering occurred.

The results of the microscopic examination of the bricks are given in Table V.

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[1] Dale, *Trans.*, 26, 215, 1927.
[2] *Bull. B.R.R.A.*, 1929, No. 20, 60 and 70.
[3] Dodd, *Trans.*, 36, 468, 1937
[4] Dale, *Trans.*, 26, 228, 1927.
[5] *Bull. B.R.R.A.*, 1926, No. 11, 85-86.
[6] Jones, *Trans.*, 21, 391, 1922.
[7] Ross, U.S. Bur. Stand., 1919, *Technical Paper* No. 116, 76.
[8] Dale, *Trans.*, 26, 213, 1927.

Controlling Swelling of Coal During Carbonization

Mr. H. J. Hodsman, of Leeds University, has been granted a patent (No. 523,250; application date, Nov. 29, 1938), in which it is pointed out that in the carbonization of coal for the manufacture of coal gas or high or low temperature coke, swelling influences the rate of heating the coal and may cause the charge to stick to the walls of the oven or retort thereby rendering it difficult to extract the coke. The properties of the resulting coke are also influenced by the kind and extent of the swelling.

In the gasification of coal in producers, coals which fuse and swell considerably tend to result in a fuel bed impervious to gases which causes a reduction in output and leads to a loss in quality of the gas. Even in the process of burning coal on grates, coals which fuse and swell cause a restriction in the supply of air to the fuel and therefore of the rate of combustion.

The patentee remarks that he has observed that if a small proportion of ammonium sulphate is present with a bituminous material during carbonization, the swelling or caking of the material is reduced.

If ammonium sulphate is added to a highly swelling coal the swelling is diminished, even as little as 1% ammonium sulphate having a marked effect. By the addition to the coal of a sufficient quantity of ammonium sulphate the formation of a coherent coke can be prevented, and the carbonized product is in the form of a loose powder.

By choosing a suitable quantity of the ammonium sulphate it is possible to reduce the swelling while leaving sufficient binding constituents to form a coke having a fine grained structure and considerable strength even though the coke may not have attained a red heat. On the other hand, a non-swelling coal when similarly treated may leave a coke residue in the form of a loose powder of less volume than the original coal.

In carrying the invention into effect samples of a highly swelling coal, crushed to pass a sieve of mesh ¼ in., were heated in a vertical tubular retort while supporting a piston free to move and exerting a pressure of 150 grammes per sq.cm. The temperature was allowed to rise at the rate of 1° C. per minute.

When untreated coal was used the rise in position of the piston showed that the coal had swollen 36%. When 1% of ammonium sulphate was incorporated with the coal before carbonization the expansion fell to 4%, and with 2% of $(NH_4)_2SO_4$ the final volume was actually less than the initial volume.

In a similar comparison, the expansion of a coal in the absence of ammonium salts was 72% whereas the expansion when 3% of NH_4CNS was added was only 6%.

It is unnecessary to use the commercially pure salt, for the results described above could be obtained by using a chemically equivalent quantity of a crude ammonium sulphate liquor. The use of ammonium sulphate to reduce the swelling of bituminous materials possesses the advantage that the salt is removed in the distillation process. It is believed that the effect obtained results from the fact that sulphate of ammonia is in a fluid state and capable of reacting with bituminous materials at the temperatures of coke formation.

Gas Undertakings' Results

Blackburn

The total quantity of gas made by the County Borough of Blackburn Gas Department during the past financial year was 951,204,000 cu.ft., which, when compared with the make of the preceding year, shows a decrease of 50,530,000 cu.ft., or 5.04%. Of the total consumption, prepayment consumers took 43.74%, ordinary consumers 33.06%, and industrial users 11.94%. At the end of March the number of ordinary meters in use was 13,083, prepayment meters 25,680, and industrial meters 80, giving a total of 38,843, as against 39,636 a year ago. The average consumption per ordinary consumer increased from 23,284 cu.ft. to 24,035 cu.ft., while that of prepayment consumers fell from 16,291 cu.ft. to 16,198 cu.ft. The average per industrial meter rose from 990,840 cu.ft. to 1,419,476 cu.ft. There is an adverse balance on the working for the year of £11,757. After the current financial year a substantial reduction in charges on income will obtain, with the extinction of a loan charge to the extent of £16,000 per annum. An increase of 15% in gas charges as from September last resulted in an additional income of almost £13,000, and for a complete financial year it is estimated that the increase should amount to £20,000.

Bo'ness

The financial statement for the year ended May 31, which was submitted at the annual meeting of the Bo'ness Gas Light Company, Ltd., showed that the income amounted to £12.539, and the expenditure to £11,135, leaving a balance of profit for the year of £1,404. With the amount brought forward, there was a total at disposal of £2,135, from which the Directors recommended the payment of a dividend of 7%, tax free, which would leave a balance of £748 to be carried forward. It was stated that the sale of gas for the year showed an increase of 3,000,000 cu.ft., when compared with the figure for the preceding twelve months.

Saltcoats

The Directors of the Saltcoats Gas Company, Ltd., report a profit of £1,398 on the operations for the year to May 31 last. They recommend the payment of a dividend at the rate of 7½%, which will leave a balance of £3,285 to be carried forward.

An Analysis of NEW INDUSTRIAL GAS APPLICATIONS

From a Paper Presented to the Annual Convention of the Natural Gas Section, American Gas Association

By
GEORGE M. PARKER,
Assistant to Vice-President and General Manager,
Mississippi River Fuel Corporation

INSTALLATIONS of the sort that I have in mind are concerned principally with the burning of gas in large existing furnaces, originally built to burn other fuels, or in furnaces which may be specially designed.

In most cases when we undertake to apply natural gas to large furnaces such as open hearths, glass tanks, reverberatories, &c., we immediately find ourselves in competition with other fuels that are quite cheap. Often it is necessary, if we are going to be able to compete at all, to sell the natural gas to be used in connexion with such furnaces on an off-peak or interruptible basis, for the competitive price that can be secured is not high enough to be of interest to us on any basis except one that will permit us to improve the load factor on our system and use a larger part of our capacity for longer periods of time. Therefore, the problem which faces us is not only the development of an application or design that will make it possible to burn gas successfully and efficiently in larger units, but the development of an application or design that will do this and in addition will permit the efficient use of other fuels in the furnaces during periods when gas may not be available. The successful application of natural gas under these conditions represents the solution of a problem in practical research and requires the careful study and analysis upon which the solution of any such problem necessarily depends.

There are several furnaces with which I am familiar that fall into the above category, and I propose to consider them. In

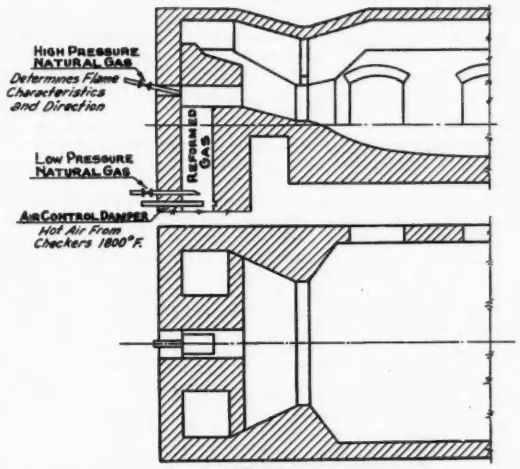

High Pressure Natural Gas
Determines Flame Characteristics and Direction
Low Pressure Natural Gas
Reformed Gas
Air Control Damper
Hot Air From Checkers 1800° F.

Fig. 1

order that the discussion will be clear, I will preface it by a few words on a subject that I have emphasized before.

Gas has been at a considerable disadvantage in high-temperature furnaces due to the fact that it ordinarily burns with a non-luminous, clear flame. The radiation from such a flame is small and hot brickwork must be depended upon to radiate the heat into the material being heated or melted. The Industry has tried various methods of giving the gas flame luminosity, with varied results and success.

In small recuperative furnaces the diffusion-combustion principle has worked quite satisfactorily, but in large, high-temperature regenerative furnaces it has not worked satisfactorily, probably due to the fact that it is difficult to control the flow of gases through such furnaces, and it is difficult to prevent the development of turbulence which breaks up the flame stratification. A further reason for failure of the diffusion-combustion principle to produce desired results in large furnaces of this type lies in the fact that it is difficult, if not impossible, to maintain proper burners in the reversing flow of extremely hot gases.

There is another way to produce a highly luminous gas flame, and that is by the production from natural gas of a new gas, different in burning characteristics and having in it quantities of finely divided free carbon which will burn with great luminosity. This second method has been very successful in connexion with certain furnace operations.

A schematic drawing of the actual design of an open hearth using this principle is shown in Fig. 1. A small reforming chamber is built between the air uptakes that normally bring hot air from the regenerators to the furnace proper. This reforming chamber is of a proper cross-section and proper depth so that when the required amount of air from the regenerators is admitted to this chamber through the control damper shown and mixed with natural gas admitted to the reforming chamber as shown, the natural gas is cracked, releasing a large amount of finely divided free carbon and producing a new gas in large volume and of comparatively low B.Th.U.

The reformed gas, carrying with it the free carbon, is picked up by a high-pressure jet of natural gas, as shown on the drawing,

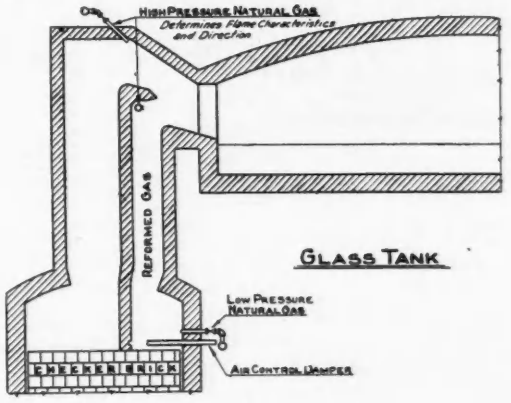


Fig. 2

and blown into the furnace. A very heavy and highly luminous flame is the result. The velocity and direction of this flame are controlled by the high-pressure jet of natural gas.

The amount of reformed gas used during a "heat" varies considerably. During the period when the charge is being cut down a larger amount of high-pressure gas is used to produce a flame of high velocity which will have a cutting effect. During the refining period a large proportion of reformed gas is used, as during this period of reaction a soft, heavy, highly luminous flame, lying close to the bath is desirable.

This method of operation has reduced the B.Th.U. required from 7% to 8%, as compared with the B.Th.U. required when firing an open hearth furnace in the conventional manner.

A most important advantage of the design shown in Fig. 1 lies in the fact that no furnace changes have been necessary which might interfere with the burning of oil, and during periods of gas shortage or interruption of gas deliveries an oil burner can be quickly substituted for the high-pressure gas jet without loss of time and without serious impairment to the efficiency of the furnace operation.

If the existing open hearth furnace was originally designed to burn producer gas and should it be desired to use producer gas as

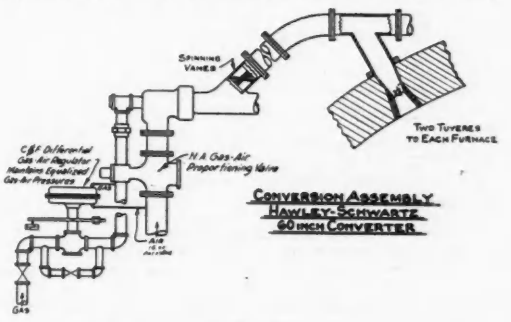


Fig. 3

a substitute fuel, it is possible to use a part of the gas checkers as a reforming chamber by small changes in design which will not interfere with the use of the gas checkers for producer gas operation. A high-pressure natural gas jet is then installed in the proper place, and the operation of the furnace on natural gas proceeds as outlined above. During periods of interruption of natural gas

deliveries the furnace can be put back on producer gas without loss of time.

Fig. 2 indicates schematically the method of adapting the reformed luminous flame method to a regenerative glass tank. A chamber is provided in which natural gas is cracked and free carbon produced. A high-pressure natural gas jet or several high-pressure jets pick up the reformed gas carrying finely divided free carbon and direct it into the melting zone of the furnace. A heavy, highly luminous flame is the result and heat is transferred directly from the radiant flame into the bath. It has been noted, although the flame temperature is low due to its rapid radiation of heat, that more batch per million B.Th.U. can be melted in a given time than with the conventional method of firing.

The same flexibility exists in this application as in the case of the open hearth furnace previously described. Either oil or pro-

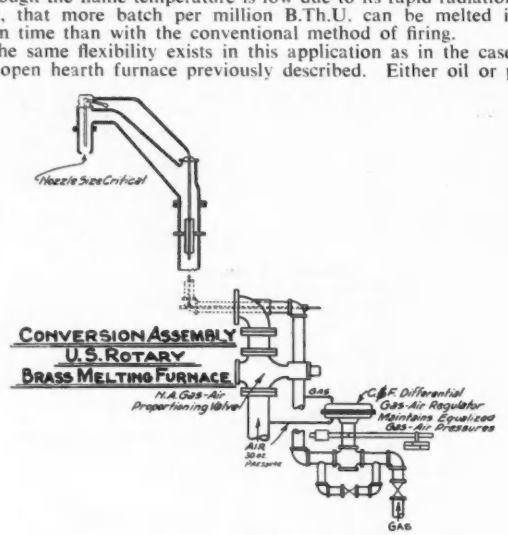


Fig. 4

ducer gas can be substituted readily for natural gas without loss of time, production, or serious drop in operating efficiency.

The method of application of natural gas to open hearth furnaces and glass tanks, represents the solution of one of our problems in practical research. Natural gas can be and is being burned by this method in furnaces of this type with high operating efficiencies and excellent results. The furnaces can be momentarily changed over to other fuels, making them an excellent outlet for off-peak or interruptible gas at prices competitive with other fuels.

We have discussed the internally fired radiant tube as an important development in the application of natural gas to industrial processes. The field this development has opened to the natural gas industry cannot be over-emphasized. With this development we are able to accomplish results that we were never able to attain before.

I have had occasion to study the conversion of Hawley-Schwartz converters, used in melting brass, copper, and various alloys, from oil firing to gas firing. The natural gas industry has had this job to do in a number of plants and somewhat different methods have been used, some of which I think are much more complicated than is necessary.

One highly satisfactory installation is shown in Fig. 3, which is a schematic drawing of the changes to be made in converting an existing oil-fired Hawley-Schwartz converter for natural gas firing. The drawing is self-explanatory. When the converter is fired with oil, air is delivered to the tuyères through an air valve at 16 oz.

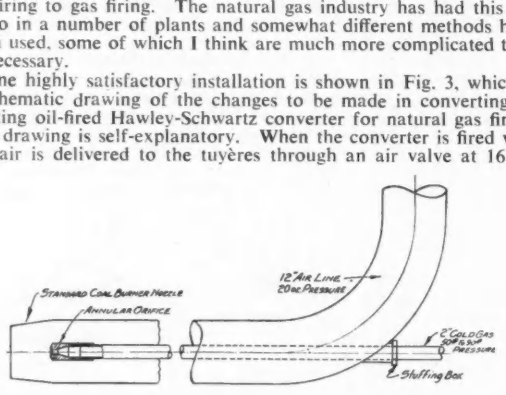


Fig. 5

gauge. In converting for gas firing this air valve is replaced with a North American proportioning valve, and a differential air-gas regulator is installed to provide that the gas and air are delivered to the proportioning at exactly the same pressures. In that way proper proportions of air and gas are maintained over the larger part of the range of the proportioning valve. Natural gas after passing through the proportioning valve is introduced into the tuyère pipe. A spinning vane is installed in the tuyère pipe at a point after the introduction of natural gas to assure turbulence and the proper mixing of air and gas in the tuyère pipe before the combustible mixture is delivered to the furnace. For gases of different B.Th.U. and flame characteristics, different velocities are necessary, and, therefore, the nozzle sizes are critical.

A conversion following this method was made to eight Hawley-Schwartz converters in one plant. They operate at temperatures in the vicinity of 2,400° F. melting brass for journal bearings. Operating results indicate that 2,620 cu.ft. of 970 B.Th.U. natural gas is required per cwt. of metal.

At the same plant where the Hawley-Schwartz converters were changed over for gas firing there were a number of U. S. rotary melting furnaces, and a similarly simple conversion was made in connexion with these furnaces in the manner shown in Fig. 4. I believe that with the explanation given previously it will not be necessary to make further explanation of Fig. 4. It was thought at the time of converting to natural gas that it might be necessary to burn a small amount of oil with the natural gas in the rotary furnaces, and for this reason you will see in Fig. 4 that a small oil pipe was left in place but it was not found necessary to use any oil, and the results have been excellent in burning natural gas.

Operating results when firing a No. 4 U. S. rotary furnace melt-

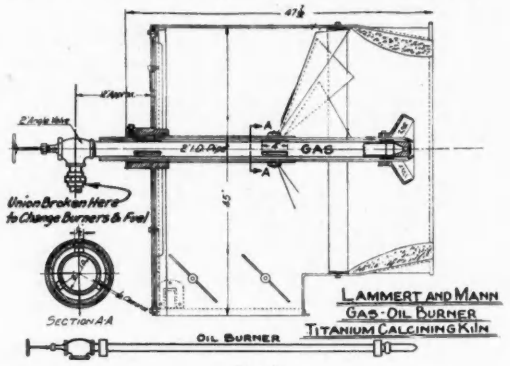


Fig. 6

ing metal for trolley wheels with 970 B.Th.U. natural gas indicate that it requires 275 cu.ft. per cwt.

Fig. 5 indicates a simple but effective method of firing a rotary cement kiln with high-pressure natural gas. The method is flexible in that natural gas can be used as the sole fuel, or it can be burned in conjunction with coal, the proportion of coal and gas being variable from 0% to 100%. The importance of this flexibility lies in the fact that deliveries of gas may be curtailed or discontinued during periods of peak demand on the gas system without inconveniencing the kiln operators to any great extent, thereby making it possible to sell gas for this purpose on an interruptible or off-peak basis.

Fig. 6 shows in some detail a burner for firing rotary titanium calciners. The gas burner is so designed that it may be removed by simply breaking one union and an oil burner inserted in its place. In this way it is possible to interrupt deliveries of gas without loss to the consumer. The design was carefully worked out with this end in view. I think the burner requires little explanation, as a study of the drawing will show the details of the burner.

Fig. 7 is a schematic drawing of a top-fired recuperative open hearth. This is a bit of practical research undertaken by one of

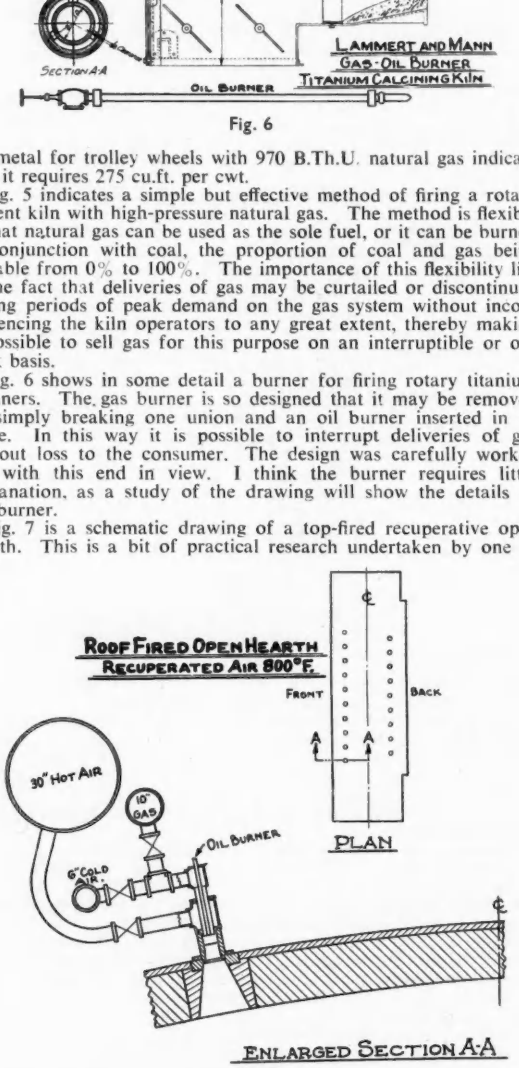


Fig. 7

the steel companies. It was intended that the furnace should operate either on oil or natural gas, but since the principal fuel used by this company at the time of the experiment was oil, an effort was made to work out a satisfactory technique for firing oil. Unfortunately, a satisfactory technique was never found for

burning oil. Steel was made but the heats were slow and costs were high. The type of oil burners used operated with high velocities, and the turbulence caused by the operation of 19 burners carried fluxes and slag to the roof, where it damaged brickwork.

Natural gas was fired in this furnace for a short time, and the results seem to indicate the possibility of satisfactory operation. The furnace was shut down before a conclusion was reached.

Until the time the furnace was shut down it could not be said that its operation was successful. However, considerable data was secured, and it seems probable that a furnace of this type can be made to work satisfactorily. This is one of the problems in practical research that has not been solved as yet, and there is much work to be done in connexion with the firing of open hearth furnaces. An experiment of this sort is invaluable in enlarging our experience and knowledge, and will serve as a guide to further research.

Several years ago I made a report on a method of reforming natural gas to produce a gas similar in burning characteristics to producer gas. This research was undertaken in order to find a way to sell natural gas to an industrial consumer whose furnaces were built for producer gas and could not be feasibly converted for the firing of gas with the flame characteristics of natural gas.

The first unit to accomplish this result was put into operation in 1934. It has been operating continuously and satisfactorily ever since. Natural gas goes into the reforming unit and comes out as a gas of approximately 150 B.Th.U. with the burning characteristics of producer gas. It passes into the existing producer gas main at about 1,800° F. and is burned in a Hegeler zinc kiln.

Since the installation of the first unit several other units have been installed for similar reasons and in order to accomplish similar results. One of these other units is operated to produce a gas for firing 16 soaking pits which were designed to operate on producer gas. This unit operated satisfactorily and continually until such time as new direct-gas-fired pits replaced the old pits. The advantage of this scheme is obvious. No money was spent by the consumer completely to rebuild his furnaces, and the furnaces will still operate on producer gas during periods of shortage of gas supply or interruption of gas deliveries.

The natural gas industry is awake to the importance of industrial sales, and is coming to a full realization of the importance of selling natural gas for industrial purposes on an interruptible basis. There is considerable talk of establishing a research foundation. This is very necessary, and the industry could well afford to spend considerable money in practical research in the field of large industrial applications.

WATER GAS AND CARBURETTED WATER GAS*

By

J. H. TAUSSIG, Jr.

The Philadelphia Gas Works Company

IN the data published in the last 40 years on water gas and carburetted water gas, almost every author states that CO_2 in the gas is undesirable. In the days when the candle power standard was in effect, there was a great incentive to reduce the CO_2 in the gas as for each 1% reduction in CO_2, there was an increase of from 3% to 4% in the candle power. Now the candle power standard has passed and CO_2 in the water gas is no longer a detriment in most cases.

The four reactions taking place in the generator during the run period are:

(1) $C + H_2O \rightarrow CO + H_2$ — 70 900 B.Th.U.
(2) $C + 2H_2O \rightarrow CO_2 + 2H_2$ 71 600 B.Th.U.
(3) $CO + H_2O \rightarrow CO_2 + H_2$ — 700 B.Th.U.
(4) $CO_2 + C \rightarrow 2CO$ — 70 200 B.Th.U.

The above reactions are all endothermic in going as indicated. Although various authorities agree that they are the reactions that do occur in the decomposition of steam by incandescent carbon, they disagree on their exact mechanism. Therefore let us consider each reaction separately. Actually reactions (1) and (2) represent the sum total of all the run reactions but reactions (3) and (4) are included as they may be useful in illustrating several points. The carbon per 1,000 cu.ft. and per 1,000,000 B.Th.U. calculated for these four reactions does not include the heating of the fuel bed but only the carbon in the water gas.

Reaction (1) $C + H_2O \rightarrow CO + H_2$ — 70 900 B.Th.U. In this reaction, one mol of carbon and one mol of steam form one mol of CO and one mol of H_2. Water gas, if made entirely from this reaction and without diluents would be of approximately 318 B.Th.U. per cu.ft. and would require 15.8 lb. of carbon per 1,000 cu.ft. of gas. The carbon per 1,000,000 B.Th.U. would be approximately 49 lb.

Reaction (2) $C + 2H_2O \rightarrow CO_2 + 2H_2$ — 70 600 B.Th.U. In this reaction one mol of carbon and two mols of steam form one mol of CO_2 and two mols of H_2. Water gas, if made entirely from this reaction, would be of approximately 213 B.Th.U. per cu.ft. and would require 10.5 lb. of carbon per 1,000 cu.ft. of gas. However, the carbon per 1,000,000 B.Th.U. would be approximately the same as reaction (1).

Reaction (3) $CO + H_2O \rightarrow CO_2 + H_2$ — 700 B.Th.U. In this reaction, one mol of CO and one mol of steam form one mol of CO_2 and one mol of H_2 with the absorption of 700 B.Th.U. The fuel in the gas per 1,000,000 B.Th.U. remains unchanged by this reaction but there is a reduction of the fuel in the gas per 1,000 cu.ft. of gas made.

Reaction (4) $CO_2 + C \rightarrow 2\ CO$ — 70 200 B.Th.U. In this reaction, one mol of CO_2 and one mol of carbon form two mols of CO. This reaction represents a reduction of CO_2 formed by either or both reactions (2) and (3) and increases the fuel in the gas.

From the above reactions, it can be seen that as far as the carbon required in the water gas per 1,000,000 B.Th.U., reactions (1) and (2) are practically the same and reactions (3) and (4) have little effect.

But it is also apparent that the carbon in the gas per 1,000 cu.ft. is less for reaction (2) than reaction (1) as stated above. Reaction (3) reduces the fuel in the gas per 1,000 cu.ft. of gas and reaction (4) increases the fuel in the gas per 1,000 cu.ft. of gas.

Therefore it can be seen that, thermally, high CO_2 in the water gas is not necessarily detrimental to water gas efficiency as far as the run is concerned.

The following reactions occur during the blow:

(A) $C + O_2 \rightarrow CO_2$ + 174 600 B.Th.U.
(B) $C + CO_2 \rightarrow 2CO$ — 70 200 B.Th.U.

Reaction (A) is exothermic and supplies the heat for the run reactions (1), (2), (3), and (4) as well as for reaction (B) which is endothermic.

In the water gas generator, reaction (A) takes place practically completely in the lower portion of the fuel bed. As the CO_2 formed progresses up through the incandescent fuel, some of the CO_2 is reduced to CO as shown in reaction (B). This reaction takes heat and carbon from the upper portions of the fuel bed, the potential heat of the CO equal to the heat of the carbon removed plus the heat removed from the fire.

Therefore, as far as heat storage for the run reactions is concerned reaction (B) should be retarded. Low time of contact and low temperatures, especially in the upper portions of the fuel bed, are the means of keeping reaction (B) at a minimum. Low fire temperatures will also reduce the sensible heat losses from the fuel bed. The sensible and potential heat losses during the blow cannot be estimated exactly, due to the uncertainty of fire temperature, temperature of exit blow gases and amount of CO_2 formed at various air-steam ratios, but it is evident that they are very considerable, both in fuel per 1,000,000 B.Th.U. and fuel per 1,000 cu.ft. of blue gas.

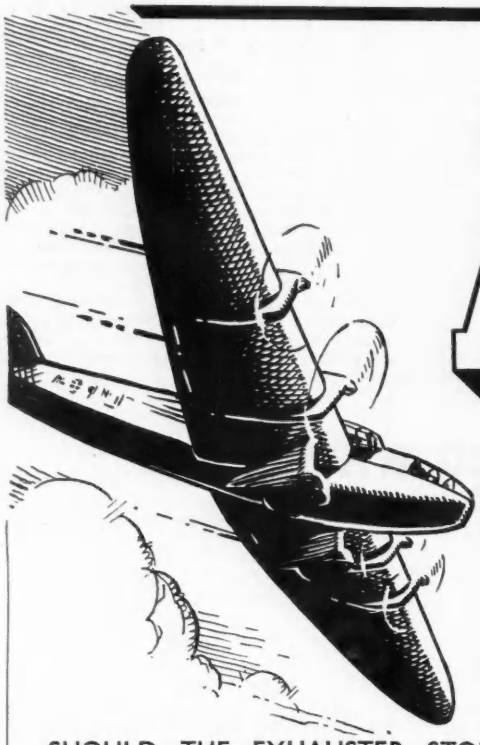
The condition that promotes reaction (2) is a low fire temperature. Low fire temperatures, especially in the upper portions of the fire, will retard reaction (4) which is undesirable from the standpoint of generator fuel consumption per 1,000 cu.ft.

However, high CO_2 in blue gas in itself does not necessarily indicate efficient blue gas production. In fact, probably in many cases high CO_2 has accompanied reduced capacities and higher operating costs and the operator has noticed this connexion and therefore worked for at least a reasonably low CO_2, the method of obtaining the desired CO_2 being the control of the air-steam ratio.

In general CO_2 in the blue gas is formed by weak fires, cold fires, or a combination of both. Weak fires, either hot or cold, are undesirable both for capacity and efficiency. Due to insufficient fuel depth, a great deal of the heat of the reactions during the blow will appear as sensible heat in the products of combustion as this sensible heat will not be extracted in the upper portions of the fire. Then, on the steam run, due to insufficient time of contact and heat storage, much of the steam will pass through the fire undecomposed, causing excessive heat losses in the sensible heat of the undecomposed steam.

Weak fires are caused by the improper relation of the up and down steam for the air-steam ratio in use. With a low air-steam ratio, the average fire temperature is relatively low. If an insufficient percentage of the total steam is not sent down through the fire, the primary oxidation and reduction zones slowly creep up through the generators, reducing the effective depth of the fire and increasing the combustible loss in the ash. "Black eyes" appear near the walls if this condition is very pronounced. Low steam decomposition, low capacity, and poor results ensue. Raising the air-steam ratio, will partially correct this condition. By raising the average fire temperature, although the percentage of down steam remains the same, there is more heat

* Presented at American Gas Association Technical Section, Joint Committee Conference of the Production and Chemical Committees, New York, May 20-22, 1940.



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available to be returned to the base of the generator on the down run, and the oxidation zone is "pushed" down to the base of the fuel bed.

Considering the average fire temperature, however, will reduce the percentage of CO_2 in the blue gas and increase the generator fuel per 1,000 cu.ft., but by keeping a low air-steam ratio and increasing the percentage of down steam sufficiently to keep the primary oxidation zone at the base of the fuel bed, high CO_2 becomes an indication of good blue gas efficiency.

Now let us consider the advantages and disadvantages of low B.Th.U., high capacity and efficiency. Due to insufficient fuel depth, a great deal of the heat of the reactions during the blow will appear as sensible heat in the products of combustion as this sensible heat will not be extracted in the upper portions of the fire. Then on the steam run, due to insufficient time of contact and heat storage, much of the steam will pass through the fire undecomposed, causing excessive heat losses in the sensible heat of the undecomposed steam.

Weak fires are caused by the improper relation of the up and down steam for the air-steam ratio in use. With a low air-steam ratio, the average fire temperature is relatively low. If an insufficient percentage of the total steam is not sent down through the fire, the primary oxidation and reduction zones slowly creep up through the generator, reducing the effective depth of the fire and increasing the combustible loss in the ash. "Black eyes" appear near the walls if this condition is very pronounced—low steam decomposition, low capacity, and poor results. Raising the air-steam ratio, will partially correct this condition. By raising the average fire temperature, although the percentage of down steam remains the same, there is more heat available to be returned to the base of the generator on the down run and the oxidation zone is "pushed" down to the base of the fuel bed.

Raising the average fire temperature, however, will reduce the percentage of CO_2 in the blue gas and increase the generator fuel per 1,000 cu.ft., but by keeping a low air-steam ratio and increasing the percentage of down steam sufficiently to keep the primary oxidation zone at the base of the fuel bed, high CO_2 becomes an indication of good blue gas efficiency.

Now let us consider the advantages and disadvantages of low B.Th.U. high CO_2 blue gas. On the Atlantic Seaboard at the present time, generator fuel is relatively high in price as compared with the residual oils. In many plants in this area, blow run gas is used to lower the generator fuel consumption, increase the carburetting oil per 1,000 cu.ft. and increase capacity. Also, some of the carburetting oil is reformed, further decreasing the generator fuel, increasing the carburetting oil per 1,000 cu.ft., and lowering the specific gravity of the resulting gas. Blow run gas in itself is not as "cheap" a gas per 1,000,000 B.Th.U. as oil gas from heavy oil. However, when carburetted with residual oil, the resulting mixture is relatively inexpensive—*i.e.*, less expensive than low CO_2 carburetted blue gas. If the blow run gas is replaced wholly or in part by inert CO_2 made by the water gas reactions (2) and (3) instead of air gas made on the usual blow run, there will be an additional reduction in the cost of the finished gas.

There is an added advantage of supplying inerts by this method as the specific gravity of the carburetted water gas made from reaction (2) will be less than if reaction (1) and blow run gas are used.

Now, let us list the results desired from a carburetted water gas set and see how they may be obtained.

(I) Good operating results.
(II) High capacity.
(III) By-product tar with a minimum amount of free carbon.
(IV) Low labour costs.

Good operating results with a price differential in favour of oil over coke require low generator fuel and relatively high oil. If the tar is worth more than boiler fuel, a high tar yield is desirable for the lowest overall cost, including gas price and tar credit. A high tar yield will raise the gas cost, but if there is a demand for the tar at a price above the cost of residual oil plus tar dehydration, low oil efficiency (*e.g.*, high tar yield) is indicated. With a price differential in favour of generator fuel over oil, then the market for tar will be the controlling factor as to high or low tar yield, but there will still be the incentive, in either case, to keep the generator fuel at a minimum if it can be done without affecting the oil efficiency desired.

Low fire temperatures promote the saving of generator fuel both on the make and on the blow. But as low fire temperatures reduce the actual percentage of oil that is reformed on passing through the fire, the amount of backrun oil must be increased. In present heavy oil practice the oil vapours are reformed during the backrun—*i.e.*, after making an up run. Therefore the fire temperatures are low enough, especially with low air-steam ratios, so that oil vapours are not cracked in space. A higher percentage of total oil reformed means a lower B.Th.U. finished gas, further decreasing the generator fuel by more carbon being deposited in the fire, and a larger percentage of the finished gas being oil gas. Low fire temperatures give a low B.Th.U. water gas, also requiring more oil for carburetting.

High capacity requires as high a blast rate as possible, limited by the blowing of fuel out of the fire. To maintain a low air-steam ratio with a high air input, a high steam rate is required. A high steam rate will give a relatively high steam rate-oil injection rate ratio, which is conducive to reducing degradation of the tar, especially when a large percentage of the total oil is reformed as a high concentration of steam, and high velocity of steam, blue gas, and oil vapours reduce the time of contact and the amount of oil reformed in space.

From the standpoint of generator fuel consumption, the lowest air-steam ratio that can be used and still supply sufficient heat for oil vaporization and fixing is the most economical as the lower air-steam ratios make cooler fires and promote reaction (2) and retard reaction (B). There is, however, the cost of the steam to be considered. The most economical point of operation may be found by plotting the cost of steam against the air-steam ratio and the cost of fuel against the air-steam ratio and selecting the air-steam ratio at which the sum of the two costs is a minimum.

Literature pertaining to heat balances and fuel required at various air-steam ratios is conspicuous by its absence. The only data available to this writer are given in "Communication No. 122 of The Institution of Gas Engineers—37th Report of the Joint Research Committee of the Institution and Leeds University. The Controlled Operation of a Carburetted Water Gas Plant—Part II." These data, due to differences between American and British practice, should probably not be taken as quantitatively exact; but there seems to be no reason that they should not be qualitatively indicative of American apparatus and conditions.

There are decided advantages for the lower air-steam ratios for blue gas. To how low a point the air-steam ratio may be reduced in carburetted water gas manufacture is a problem to be solved by trial. The trend is that it can be carried considerably below the lowest limit of the English tests.

Trade News

Gas-Fired Water Heaters

The ever-increasing demand for economy in labour coupled with the convenience and utility of maintaining a supply of hot water throughout the premises places gas-fired apparatus in the forefront of the many forms of heating systems now available. A new catalogue lately produced by Thomas Potterton (Heating Engineers). Ltd., of Cavendish Works, Buckhold Road, Wandsworth, S.W.18, covers the full range of both hot water and central heating requirements of the architect, builder, or householder in equipping home or factory with an efficient gas-heated installation, whether it be an entirely new system or the re-modelling of an existing one.

For hot water supply the catalogue covers thermal and lagged storage sets standardized with cylinders from 28 to 200 gallons capacity, or rectangular tanks from 16 to 60 gallons capacity, while other combinations of boiler power and storage capacities can be supplied to meet any demand. On the central heating side, "Rex" boilers are produced in capacities ranging from 66,000 to 1,250,000 B.Th.U. hourly, while for smaller duties "Victor" or "Empire" units range from 16,000 to 45,000 B.Th.U. For hot water supply, the "Emperor" totally-enclosed thermal storage set is particularly neat in appearance with its streamlined white enamel finished insulated steel casing.

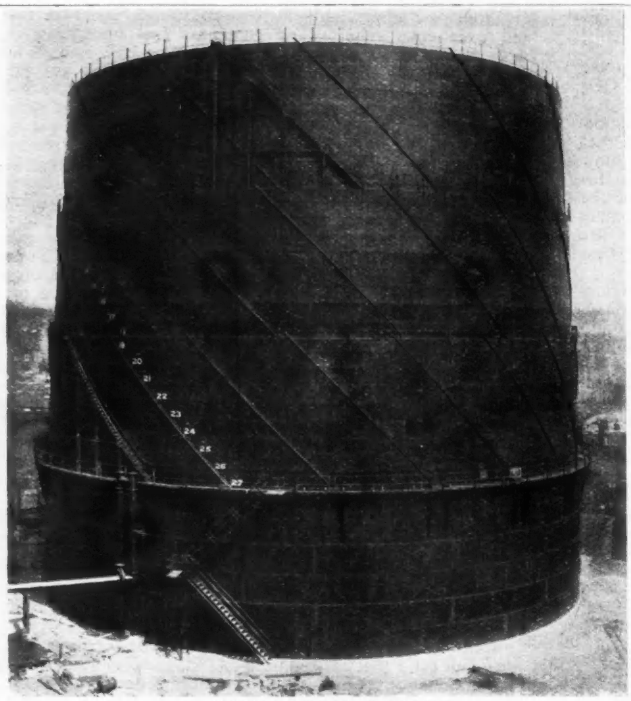
Several pages are devoted to automatic controls and accessories, including gas pressure operated valves, which are independent of any outside motive power, cut-out valves, the ingenious "night valve" system for stopping the secondary circuit when not required, relay valves, and automatic air and clock controls. Throughout the catalogue photographs and diagrams make for a ready understanding of the design of the apparatus and the layout and arrangement of typical systems, full details and specifications of the equipment being given, of course, in every case.

Cast-Iron Pipes and Specials

The Staveley Coal & Iron Company's new enlarged catalogue of cast-iron pipes and specials is a comprehensive publication running to some 360 pages. As might be expected in a catalogue of this magnitude, every aspect of the subject is fully covered, while the fullest details and specifications, together with diagrams, are given of every individual item, reference to which is simplified by an excellent index.

An interesting introduction gives some idea of the wide scope and activities of the firm, and a series of photographs of various departments and plant, accompanied by descriptive matter, tell a vivid story of the process of manufacture from start to finish. Of particular interest and value at this time is the section devoted to a quick method of repairing a damaged main by means of flexible joint collars, the only tool needed for the fixing of which is a spanner. Finally, a number of useful tables of equivalents are included.

Printed on art paper throughout and attractively bound in a dark blue cover, this catalogue should prove a valuable work of reference on the bookshelf of every gas engineer and distribution superintendent; for it may be confidently claimed that no single item appertaining to main-laying—from caps and collars to hatchboxes and syphons—is omitted from the publication.



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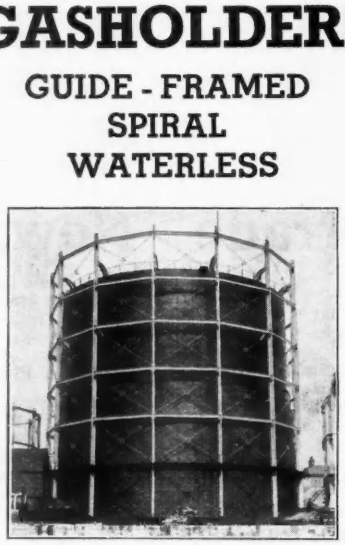

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Products Prices

The London Market

Aug. 12.

Present values of tar products are as under: There is very little export demand for pitch, and the price is quite nominal, creosote is about 4¼d. to 5d. per gallon, refined tar 3¾d. to 4d. The price of pure toluole under the Ministry of Supply Toluene No. 2 Order, 1940, is 2s. 5d. per gallon, pure benzole 1s. 10d., 95/160 solvent naphtha 1s. 11d. to 2s., and 90/160 pyridine about 18s. 6d., all per gallon naked, refined naphthalene crystals £23 per ton in bags, all *ex* Makers' Works.

The Provinces

Aug. 12.

The average prices of gas-works products during the week were: Pitch.* Toluole, naked, North, 1s. 9½d. (Controlled by the Ministry of Supply Order No. 1, which fixes the maximum price at which this material may be sold). Coal tar, crude naphtha, in bulk, North, 9d. to 9½d. Solvent naphtha, naked, North, 1s. 8d. to 1s. 9d. Heavy naphtha, North, 1s. 4½d. to 1s. 5½d. Creosote, *ex* works, in bulk, North, liquid and salty, 4½d. to 4¾d.; Scotland, 4¾d. to 4¾d.; low gravity, 4½d. to 4¾d. Fuel Grade, 4d. to 4¼d. Carbolic acid, 60's. 3s. 6d. to 3s. 7½d. Naphthalene, £15 to £20. Salts, 75s. to 85s., bags included. Anthracene, "A" quality, 4½d. to 4¾d. per minimum 40% purely nominal. Heavy oil: Unfiltered anthracene oil, (min. gr. 1,080), 5¼d. to 5½d.; filtered heavy oil (min. gr. 1,080), 5¾d. to 6d.; heavy anthracene oil gr. less than 1,080, 6d. to 6¼d.

*Pitch.—Editorial Comment on quotations for pitch and crude tar will be found on page 280 of to-day's issue of the "JOURNAL."

Scotland

GLASGOW, Aug. 10.

Only a limited amount of new business has been placed during the week, but prices generally are unchanged.

Refined tar.—Quite a steady throughput is maintained in both home and export markets, with values at 4¼d. to 4½d. per gallon and 3½d. per gallon respectively, both f.o.r. naked.

Creosote oil is quietly steady, with values as follows: Specification oil, 5d. to 5¼d. per gallon; low gravity, 6d. to 6¼d. per gallon; neutral oil, 5¾d. to 6d. per gallon; all *ex* Works in bulk.

Cresylic acid.—Very little business is being placed in this product, and prices are easy, with Pale 97/99% at 1s. 11d. to 2s. per gallon; Pale, 99/100%, 2s. 2d. to 2s. 4d. per gallon; Dark, 97/99%, 1s. 7d. to 1s. 9d. per gallon; all *ex* Works in buyers' packages.

Crude naphtha is valued at 6½d. to 7½d. per gallon *ex* Works in bulk, according to quality.

Solvent naphtha is unchanged. 90/160 is 1s. 8½d. to 1s. 9d. per gallon, and 90/190 heavy naphtha is 1s. 4½d. to 1s. 5½d. per gallon.

Motor benzole is 1s. 8d. to 1s. 8½d. per gallon.

Pyridine.—90/160 grade is 17s. to 18s. per gallon, and 90/140 grade is 19s. to 20s. per gallon.

Trading Result

Falk, Stadelmann & Co.—Profit for the year ended March 31, £97,602 (£82,803); brought forward, £28,715. Taxation, £10,895 (£9,219); A.R.P. expenditure, £4,481; contributions to staff pensions fund, £6,209 (£5,757); and preference dividend, £31,500. Ordinary dividend 7% (6%). Carried forward, £32,807.

COMPANY MEETING

Low-Temperature Carbonisation, Ltd.

Addressing the shareholders at the Ordinary General Meeting of Low-Temperature Carbonisation, Ltd., the Chairman (Col. W. A. Bristow) stated that the trading profit for the year was £70,034—an increase of £27,091 on last year's figure. After providing for income-tax, depreciation, debenture interest, &c., there was a credit balance of £29,401, to which was added the balance brought forward of £33,265, making a total of £62,666. The sales of "Coalite" exceeded all previous records, owing to the great increase in the number of households and public institutions now using this fuel and to the severe character of the weather. At present they had no "Coalite" in stock, and orders were in excess of supplies. The sales of coal oils and liquid products reached much higher levels as a result of the completion of the new refinery, which for the second half of the year was operating at maximum output. Petrol, diesel, and fuel oils were being produced on a large scale and were distributed by the Petroleum Board to a number of important undertakings, many of which had not previously used any coal oils. On the chemical side the results were equally satisfactory, and valuable markets had been established for the various types of cresylic acid and other products. Since the commencement of the war they had exported to the U.S.A. and Canada large quantities of refined acids for the mining, chemical, and plastic industries. The improvement in trading was not due to the war, but had been attained in spite of the war and was occasioned solely by the national development of the Company's business. The results constituted a striking tribute to the technical and economic value of the "Coalite" process of low-temperature carbonization.

Since the war began they had been actively engaged on a number of new problems, and during the past six months some notable advances had been made, which would have an extremely beneficial effect on their business after the war. They might fairly claim to have solved the many difficult problems in connexion with the production of oils from coal and their subsequent refining. They had recently produced Motor "Coalite"—a solid fuel—as a substitute for petrol for road transport vehicles. Official tests had shown it to be eminently satisfactory, and a number of road transport operators were now using it with excellent results in portable gas producer units.

A dividend at the rate of 3½%, less tax, was declared, leaving £30,442 to be carried forward.

Dividends Announced

East Hull

The Directors of the East Hull Gas Company have declared dividends for the half-year ended June 30, 1940, at the following rates per annum: On the Ordinary Stock, 5%. On the 4½% Debenture Stock, 4½%. These dividends are payable on Aug. 15.

Cambridge

Dividends on the ordinary stock of the Cambridge University and Town Gas Light Company for the half-year ended June 30 last have been declared at the following rates—all less income-tax: On the Consolidated Original Stock, 5%. On the "B" Stock, 3½%. On the "C" Stock, 2½%. These dividends are payable to-day.

Horley

The Directors of the Horley District Gas Company resolved at a recent meeting to pay interim dividends on the ordinary capital stocks on account of the year ending Dec. 31, 1940, at the same rates as last year—viz.: On the "A" stock, 5% actual. On the "B" stock, 3½% actual.

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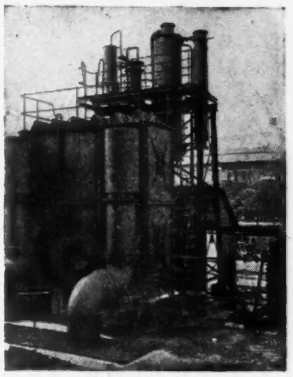
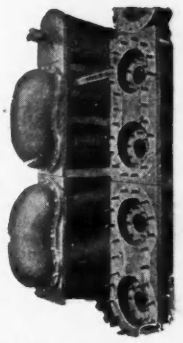


"Permac" joints in a Gas Works



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GAS STOCKS AND SHARES

The volume of business on the Stock Exchange continued on a small scale during the past week. Apart from the vicissitudes of a war-time atmosphere, this can also be attributable to the usual August easing off on account of holidays, which though not up to the usual exodus, are still to a limited degree being taken. Prices, however, remain firm, and although at one time during the week British Funds were inclined to sag, any setbacks were eventually overcome, and quotations closed practically unaltered—2½% Consols being quoted at 73, the same price as a week ago. Home rails were inclined to weaken, while leading industrials had very few buyers or sellers. A few enquiries came in for rubber shares, but oil and gold mining shares remained very quiet.

As elsewhere, the Gas Market was also very quiet, business being almost confined to forced sales, which is only to be expected at current prices. It will be seen that South Metropolitan, Tottenham, and Uxbridge have now been marked *ex* div., and of these the heaviest decrease was that of Tottenham with a fall of 7 points to 73 on a drop of 12s. 6d.% in the interim dividend. On the other hand, Gas Light units made a further small advance of 3d. to 14s., and some of the Company's fixed-interest stocks also recovered. Apart from these, there were no other changes of importance in either the Supplementary or Provincial Lists.

As intimated in last week's Report, the Stock and Share Lists appear below in their curtailed form, and contain a full return of gas stocks and shares now appearing in the official and Supplementary Lists.

Quotations on the London and Provincial Stock Exchanges

OFFICIAL LIST

Issue. £	When ex-Dividend.	Dividends. Pref. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Aug. 9.	Rise or Fall on Week.
1,767,439	Mar. 11	8	7	Alliance & Dublin Ord. ...	90—100	...
374,000	July 1	4	4	Do. 4 p.c. Deb. ...	90—95	...
957,608	May 13	5	5	Asscd. Gas & Water U'd'ts Ord.	12/—14/	..
500,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	15/6—17/6	...
535,545	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	14/6—16/6	...
336,646	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	12/—14/-	—/6
561,370	Feb. 19	7	7	Barnet Ord. 7 p.c.	113—118	...
300,000	Apl. 8	1/4½	1/9⅜	Bombay, Ltd.	19/6—21/6	...
690,407	Feb. 26	7	7	Bournemouth 7 p.c. max. ...	115—120	...
362,025	June 17	4	4	Do. 4 p.c. Deb. ...	90—95	...
659,955	Feb. 19	7½	6¾	Brighton, &c., 5 p.c. Con. ...	80—90	—2½
855,000	Mar. 11	7	8	Brit. Gas Light Ord.	82—92	...
545,000	June 17	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...
120,000	,,	4	4	Do. 4 p.c. Red. Deb.	75—80	...
10,000	Nov. 6, '33	6	4	Cape Town, Ltd., 4½ p.c. Cu. Pf.	¼—¾	...
626,860	July 15	5/10	6	Cardiff Con. Ord.	89—94	...
24,500	Apl. 8	7	7	Colombo Ord. 7 p.c. Pref. ...	19/6—21/6	...
764,169	Mar. 26	—/11.48	—/11.48	Colonial Gas Assn. Ltd. Ord. ...	14/6—16/6	..
400,000	,,	1/3.30	1/3.30	Do. 8 p.c. Pref. ...	20/—22/-	...
1,748,935	July 22	2	3	Commercial Ord.	37—42	..
620,000	June 10	3	3	Do. 3 p.c. Deb.	58—63	...
286,344	Feb. 19	5	5	Do. 5 p.c. Deb.	88—93	..
807,560	Feb. 12	7	7	Croydon sliding scale	88—93	...
644,590	,,	5	5	Do. max. div.	82—87	...
620,385	July 1	5	5	Do. 5 p.c. Perp .Deb. ...	90—95	...
179,500	Feb. 12	5/20	5/20	East Surrey 'B,' 5 p.c.	93—98	...
176,461	June 17	5	5	Do. 5 p.c. Deb. (Irred.)...	90—95	...
250,000	July 8	4	6	Gas Consolidation Ord. 'B' ...	13/—15/-	...
250,000	May 13	4	4	Do. 4 p.c. Red. Cum. Pref.	15/—17/-	...
19,152410	July 29	3/8	4½	Gas Light & Coke Ord. ...	13/6—14/6a	+/3
2,600,000	,,	3½	3½	Do. 3½ p.c. max.	54—59*	...
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	75—80*	...
2,993,000	July 8	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	78—83	...
8,602,497	June 3	3	3	Do. 3 p.c. Con. Deb. ...	65—70	+3
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	99—104	...
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	97—102	+2
700,000	Mar. 11	3¼	3¼	Do. 3¼ Red. Deb. ...	80—85	...
5,600,000	May 13	4	8	Imperial Continental Cap. ...	30—40	—2½
43,820	July 29	3½	3½	Do. 3½ p.c. Red. Deb. ...	63—68	...
231,978	Feb. 19	5	5	M.S. Utility 'C' Cons.... ...	70—75	...
918,657	,,	4	4	4 p.c. Cons. Pref.	75—80	—2
675,000	May 6	†4	†4	Montevideo, Ltd.	52—57	...
300,000	Apl. 29	9	7	Oriental, Ltd.	108—113	...
368,537	June 3	7	8	Plymouth & Stonehouse 5 p.c.	90—100	...
621,667	Feb. 5	8½	8½	Portsmouth & Gosport Cons.	100—105	...
648,999	Apl. 29	1/1½	1/1	Severn Val. Gas Cor. Ld. Ord.	14/—16/-	...
597,972	Mar. 11	—/10⅜	—/10⅜	Do. 4½ p.c. Cum. Pref. ...	16/—18/-	...
2,528,714	April 29	1/2⅝	1/—	South East'n Gas Cn. Ld. Ord.	11/—13/-	...
1,000,000	Mar. 4	—/10⅜	—/10⅜	Do. 4½ p.c. Red. Cum. Pref.	14/—16/-	...
1,068,869	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	13/—15/-	...
6,709,895	Aug. 5	4	4	South Met. Ord.	49—54*	...
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	98—108*	—2
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	70—75*	—2
1,895,445	July 1	3	3	Do. 3 p.c. Perp. Deb. ...	60—65	...
1,000,000	July 15	5	5	Do. 5 p.c. Red. Deb. ...	95—100	...
1,543,795	July 22	3	4	South Suburban Ord. 5 p.c. ...	60—70	...
512,825	July 8	5	5	Do. 5 p.c. Perp. Pref. ...	88—93	...
500,000	,,	4	4	Do. 4 p.c. Perp. Pref. ...	71—76	...
250,000	,,	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	80—85	...
888,587	June 10	5	5	Do. 5 p.c. Perp. Deb. ...	95—100	...
750,541	Feb. 5	5	5½	Southampton Ord.	70—75	...
350,000	Feb. 12	5½	5½	Swansea 5½ p.c. Red. Pref. ...	92—97	...
1,076,495	Aug. 5	5	5	Tottenham & District Ord. ...	68—78*	—7
338,555	,,	5	5	Do. 5 p.c. Pref.	88—93*	—2
453,380	June 10	4	4	Do. 4 p.c. Perp. Deb. ...	82—87	...
1,247,505	May 20	4	6	U. Kingdom Gas Cor. Ord. ...	12/6—14/6	...
1,085,952	May 13	4½	4½	Do. 4½ p.c. 1st Cum. Pref. ...	14/—16/-	...
772,709	,,	4	4	Do. 4 p.c. 1st Red. Cum.Pref.	14/—16/-	...
745,263	June 17	4½	4½	Do. 4½ p.c. 2nd Non.Cum. Pf.	12/6—14/6	...
1,200,000	Mar. 18	3½	3½	Do. 3½ p.c. Red. Deb. ...	83—88	...
380,606	Aug. 5	7	6⅝	Uxbridge, &c., 5 p.c.	93—98*	—2
1,371,138	July 8	3½	4	Wandsworth Consolidated ...	67—72	...
2,525,768	,,	4	4	Do. 4 p.c. Pref.	70—75	...
1,343,964	June 17	5	5	Do. 5 p.c. Deb.	90—95	...
383,745	,,	4	4	Do. 4 p.c. Deb.	80—85	...
558,342	July 15	6	5	Watford & St. Albans Ord. ...	88—93	...
300,000	June 10	3½	3½	Do. 3½ p.c. Red. Deb. ...	85—90	...

SUPPLEMENTARY LIST

Issue. £	When ex-Dividend.	Dividends. Pref. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Aug. 9.	Rise or Fall on Week.
351,685	June 17	5	5	Brighton, &c., 5 p.c. Perp. Deb.	90—95	...
28,700	, 17	5½	5½	Do. 5½ p.c. Red. Deb. 1942 ...	96—101	...
415,250	,, 17	4	4	Bristol Gas Co., 4 p.c. New Deb.	85—90	...
140,205	July 29	7	7	Cambridge, &c., 7 p.c. Cons. 'B'	100—110	...
295,932	Mch. 4	5	5	Cheltenham, 5 p.c. Cons. Ord....	90—95	...
42,500	July 1	4	4	Do. 4 p.c. Perp. Deb....	82—87	...
150,000	Feb. 12	4	4	Croydon Gas, 4 p.c. Pref. (Irr.)	72—77	—5
130,000	July 1	4	4	Do. 4 p.c. Deb. ...	75—80	—7
146,700	Feb. 12	5½	5½	East Surrey, 5½ p.c. Pref. 'A' ...	100—110	...
53,220	,, 12	6	6	Do. 6 p.c. Cum. Pref. ...	105—115	...
117,425	,, 5	8	8	East Wight, 5 p.c. Cons. Ord. ...	100—110	...
...	Mar. 4	6	5⅝	Eastbourne, 'B' 3½ p.c....	78—83	...
239,135	July 8	5	5	Gas Consolidation 'A' Ord. (£1)	13/6—15/6	...
156,600	Feb. 19	5	5	Hampton C't, 5 p.c. Cons. Ord.	75—85	...
18,000	June 10	7	7	Malta & Med'n., 7 p.c. 1st Pref.	60—65	...
10,845	,, 10	7½	7½	Do. 7½ p.c. 2nd Pref.	60—65	...
50,000	Feb. 19	£5 19 6	£5 19 6	Mid. South. Util., 'A' Cons. 5 p.c.	63—73	...
65,000	Mch. 18	5	5	North Middlesex, 5 p.c. Pref. ...	92—97	...
70,000	,, 11	5	5	Plymouth & Stone., 5 p.c. Deb.	90—95	...
76,501	July 1	4	4	Reading, 4 p.c. Perp. Deb. ...	75—80	...
74,777	April 1	4	4	Romford, 4 p.c. Debs. (Reg.) ...	85—90	...
21,000	June 10	5	5	Slough, 5 p.c. Perp. Deb. ...	90—95	...
211,740	,, 17	5	5	Southampton, 5 p.c. Red. Deb.	96—101	..
363,575	July 1	5	5	Tottenham, 5 p.c. Reg. Red. Mt.	95—100	...
202,019	Mch. 18	7½	6⅝	Tunbridge Wells, 4 p.c. Scale ...	75—85	...
135,257	June 10	5	5	Uxbridge &c., 5 p.c. Perp. Deb.	90—95	...

PROVINCIAL EXCHANGES

347,756	July 26	6	5	Bath Cons.	98—103	...
122,577	Feb. 19	7	7	Blyth 5 p.c. Ord.	113—118	...
1,667,250	July 15	5	5	Bristol, 5 p.c. max.	90—92	...
120,420	June 17	4	4	Do. 1st 4 p.c. Deb.	94—96	...
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	92—95	...
328,790	,,	5	5	Do. 5 p.c. Deb.	108—111	...
157,150	Aug. 5	6½	5	Chester 5 p.c. Ord.	98—101*	..
92,500	June 17	4	4	Do. 4 p.c. Pref.	80—85	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	80—85	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	94—98	...
542,270	Feb. 12	6	9	Derby Cons.	103—108	...
55,000	June 10	4	4	Do. 4 p.c. Deb.	96—102	...
10,000	Feb. 19	10	10	Great Grimsby 'A' Ord. ...	170—180	...
6,500	,,	10	10	Do. 'B' Ord.	170—180	...
79,000	,,	10	10	Do. 'C' Ord.	160—170	...
732,000	Feb. 19	4	4	Hartlepool G. & W. Cn. & New	63—68	...
2,167,410	Feb. 19	6	6	Liverpool 5 p.c. Ord.	98—100	...
245,500	June 17	5	5	Do. 5 p.c. Red. Pref. ...	97½—100½	...
306,083	July 15	4	4	Do. 4 p.c. Deb.	99—101*	...
20,000	June 24	5	5	Long Eaton 5 p.c. Pref.	9—11	...
80,000	June 24	5	5	Do. 5 p.c. Deb.	100—105	...
2,430,267	July 29	5 7/10	5	Newcastle and Gateshead Con.	146/—15/6a*	...
682,856	,,	4	4	Do. 4 p.c. Pref.	73—75	—5½
776,706	Dec. 27	3½	3½	Do. 3½ p.c. Deb.	80—85	...
277,285	April 24	5	5	Do. 5 p.c. Deb. '43 ...	97—102	...
274,000	July 26	5	5	Newport (Mon.) Ord.	89—93	...
13,200	Mch. 26	7	8⅝	Pontyp'l Gas & W. 10 p.c. 'A'	11½—12½	...
13,600	,,	5	6	Do. 7 p.c. 'B'	9½—10½	...
40,000	,,	5	6	Do. 7 p.c. 'C'	9½—10½	...
106,280	Aug. 5	8	10	Preston 'A' 10 p.c.	157—167*	—3
188,219	,,	7	7	Do. 'B' 7 p.c.	113—123*	—2
1,806,339	Feb. 26	6½	6½	Sheffield Cons.	119—122	...
95,000	July 8	4	4	Do. 4 p.c. Deb.	97— 99	...
332,351	Feb. 5	6	6	Sunderland 6 p.c. max. ...	107—112	...
140,778	Feb. 12	5	5	Weston-super-Mare Cons. ...	88—92	...
64,338	June 24	4	4	Do. 4 p.c. Deb.	90—95	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	140—150	...

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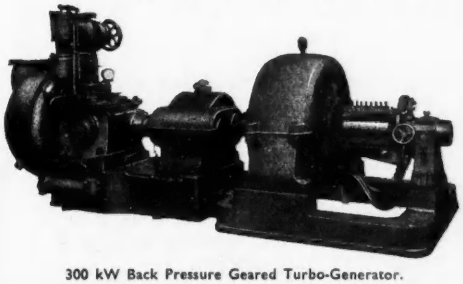

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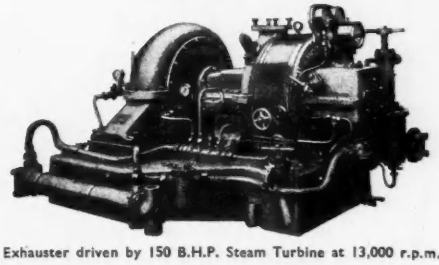

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